PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Mun-churl KIM, et al.

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Confirmation No. 5478 Group Art Unit: NOT YET ASSIGNED

Filed: December 4, 2000 Examiner: NOT YET ASSIGNED

For: TEXTURE DESCRIPTION METHOD AND TEXTURE-BASED IMAGE RETRIEVAL METHOD USING GABOR FILTER IN FREQUENCY DOMAIN

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE DRAWINGS:

Please replace Fig. 2 with the enclosed proposed drawing correction.

IN THE CLAIMS:

Please delete claims 1-22 without prejudice or disclaimer.

Please add the following new claims.

--23. A texture description method using a Gabor filter in a frequency domain for describing texture information of an image, comprising:

(a) converting a time domain image represented in a time domain into a frequency domain image represented in a frequency domain;

(b) filtering the frequency domain image via a Gabor filter having NxM filter regions to produce a filtered image, wherein N and M are predetermined positive integers;

(c) determining texture feature values of the filtered image for respective channels, wherein said channels represent a frequency domain division layout corresponding to the NxM filter regions of the Gabor filter; and

(d) determining an image texture descriptor of the frequency domain image using the texture feature values.

24. The method of claim 23, wherein the operation (a) comprises:

(a1) converting the time domain image into the frequency domain image via a two-dimensional Fourier-transformation operation,

wherein the frequency domain image is an image of an orthogonal coordinate system frequency domain.

25. The method of claim 23, wherein the operation (a) comprises:

(a1) converting the time domain image into the frequency domain image via a Radon-transformation operation and a one-dimensional Fourier-transformation operation,

wherein the frequency domain image is an image of a polar coordinate system frequency domain.

26. The method of claim 23, wherein the operation (c) comprises:

(c1) determining the frequency domain division layout based one of a human visual system ("HVS").

27. The method of claim 26, wherein the operation (c1) comprises:

(c1a) defining channels within the frequency domain division frequency layout by:

(c1a1) dividing the frequency domain by an octave interval in a radial direction away from an origin of the frequency domain; and

(c1a2) dividing the frequency domain by a division resolving power interval in the angular direction over 180 degrees of the frequency domain.

28. The method of claim 26, wherein the operation (c) further comprises:

(c2) prioritizing channels of the frequency domain division layout.

29. The method of claim 26, wherein operation (c) further comprises:

(c2) calculating at least one of an energy mean value and an energy variance value for the channels of the filtered image; and

(c3) determining features values for the filtered image based on the at least one of the energy mean value and the energy variance value.

30. The method of claim 29, wherein the operation (d) comprises:

(d1) determining the image texture descriptor based on at least one of an energy of a DC channel of the frequency domain division frequency layout, a variance of all pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

31. The method of claim 30, wherein the operation (d1) comprises:

(d1a) determining the image texture descriptor based on the energy of the DC channel, the variance of all of the pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

32. The method of claim 24, wherein the operation (c) comprises:

(c1) determining the frequency domain division layout based one of a human visual system ("HVS").

33. The method of claim 32, wherein the operation (c1) comprises:

(c1a) defining channels within the frequency domain division frequency layout by:

(c1a1) dividing the frequency domain by an octave interval in a radial direction away from an origin of the frequency domain; and

(c1a2) dividing the frequency domain by a division resolving power interval in the angular direction over 180 degrees of the frequency domain.

34. The method of claim 32, wherein the operation (c) further comprises:

(c2) prioritizing channels of the frequency domain division layout.

35. The method of claim 32, wherein operation (c) further comprises:

(c2) calculating at least one of an energy mean value and an energy variance value for the channels of the filtered image; and

(c3) determining features values for the filtered image based on the at least one of the energy mean value and the energy variance value.

36. The method of claim 35, wherein the operation (d) comprises:

(d1) determining the image texture descriptor based on at least one of an energy of a DC channel of the frequency domain division frequency layout, a variance of all pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

37. The method of claim 36, wherein the operation (d1) comprises:

(d1a) determining the image texture descriptor based on the energy of the DC channel, the variance of all of the pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

38. The method of claim 25, wherein the operation (c) comprises:

(c1) determining the frequency domain division layout based one of a human visual system ("HVS").

39. The method of claim 38, wherein the operation (c1) comprises:

(c1a) defining channels within the frequency domain division frequency layout by:

(c1a1) dividing the frequency domain by an octave interval in a radial direction away from an origin of the frequency domain; and

(c1a2) dividing the frequency domain by a division resolving power interval in the angular direction over 180 degrees of the frequency domain.

40. The method of claim 38, wherein the operation (c) further comprises:

(c2) prioritizing channels of the frequency domain division layout.

41. The method of claim 38, wherein operation (c) further comprises:

(c2) calculating at least one of an energy mean value and an energy variance value for the channels of the filtered image; and

(c3) determining features values for the filtered image based on the at least one of the energy mean value and the energy variance value.

42. The method of claim 41, wherein the operation (d) comprises:

(d1) determining the image texture descriptor based on at least one of an energy of a DC channel of the frequency domain division frequency layout, a variance of all pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

43. The method of claim 42, wherein the operation (d1) comprises:

(d1a) determining the image texture descriptor based on the energy of the DC channel, the variance of all of the pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

44. A computer readable medium containing a program that executes a routine, comprising:

(a) converting a time domain image represented in a time domain into a frequency domain image represented in a frequency domain;

(b) filtering the frequency domain image via a Gabor filter having NxM filter regions to produce a filtered image, wherein N and M are predetermined positive integers;

(c) determining texture feature values of the filtered image for respective channels, wherein said channels represent a frequency domain division layout corresponding to the NxM filter regions of the Gabor filter; and

(d) determining an image texture descriptor of the frequency domain image using the texture feature values.

45. The computer readable medium of claim 44, wherein the operation (a) comprises:

(a1) converting the time domain image into the frequency domain image via a two-dimensional Fourier-transformation operation,

wherein the frequency domain image is an image of an orthogonal coordinate system frequency domain.

46. The computer readable medium of claim 44, wherein the operation (a) comprises:

(a1) converting the time domain image into the frequency domain image via a Radon-transformation operation and a one-dimensional Fourier-transformation operation,

wherein the frequency domain image is an image of a polar coordinate system frequency domain.

47. The computer readable medium of claim 44, wherein the operation (c) comprises:

(c1) determining the frequency domain division layout based one of a human visual system ("HVS").

48. The computer readable medium of claim 47, wherein the operation (c1) comprises:

(c1a) defining channels within the frequency domain division frequency layout by:

(c1a1) dividing the frequency domain by an octave interval in a radial direction away from an origin of the frequency domain; and

(c1a2) dividing the frequency domain by a division resolving power interval in the angular direction over 180 degrees of the frequency domain.

49. The computer readable medium of claim 47, wherein the operation (c) further comprises:

(c2) prioritizing channels of the frequency domain division layout.

50. The computer readable medium of claim 47, wherein operation (c) further comprises:

(c2) calculating at least one of an energy mean value and an energy variance value for the channels of the filtered image; and

(c3) determining features values for the filtered image based on the at least one of the energy mean value and the energy variance value.

51. The computer readable medium of claim 49, wherein the operation (d) comprises:

(d1) determining the image texture descriptor based on at least one of an energy of a DC channel of the frequency domain division frequency layout, a variance of all pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

52. The computer readable medium of claim 51, wherein the operation (d1) comprises:

(d1a) determining the image texture descriptor based on the energy of the DC channel, the variance of all of the pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

53. The computer readable medium of claim 45, wherein the operation (c) comprises:

(c1) determining the frequency domain division layout based one of a human visual system ("HVS").

54. The computer readable medium of claim 53, wherein the operation (c1) comprises:

(c1a) defining channels within the frequency domain division frequency layout by:

(c1a1) dividing the frequency domain by an octave interval in a radial direction away from an origin of the frequency domain; and

(c1a2) dividing the frequency domain by a division resolving power interval in the angular direction over 180 degrees of the frequency domain.

55. The computer readable medium of claim 53, wherein the operation (c) further comprises:

(c2) prioritizing channels of the frequency domain division layout.

56. The computer readable medium of claim 53, wherein operation (c) further comprises:

(c2) calculating at least one of an energy mean value and an energy variance value for the channels of the filtered image; and

(c2) determining features values for the filtered image based on the at least one of the energy mean value and the energy variance value.

57. The computer readable medium of claim 56, wherein the operation (d) comprises:

(d1) determining the image texture descriptor based on at least one of an energy of a DC channel of the frequency domain division frequency layout, a variance of all pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

58. The computer readable medium of claim 57, wherein the operation (d1) comprises:

(d1a) determining the image texture descriptor based on the energy of the DC channel, the variance of all of the pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

59. The computer readable medium of claim 46, wherein the operation (c) comprises:

(c1) determining the frequency domain division layout based one of a human visual system ("HVS").

60. The computer readable medium of claim 59, wherein the operation (c1) comprises:

(c1a) defining channels within the frequency domain division frequency layout by:

(c1a1) dividing the frequency domain by an octave interval in a radial direction away from an origin of the frequency domain; and

(c1a2) dividing the frequency domain by a division resolving power interval in the angular direction over 180 degrees of the frequency domain.

61. The computer readable medium of claim 59, wherein the operation (c) further comprises:

(c2) prioritizing channels of the frequency domain division layout.

62. The computer readable medium of claim 59, wherein operation (c) further comprises:

(c2) calculating at least one of an energy mean value and an energy variance value for the channels of the filtered image; and

(c3) determining features values for the filtered image based on the at least one of the energy mean value and the energy variance value.

63. The computer readable medium of claim 62, wherein the operation (d) comprises:

(d1) determining the image texture descriptor based on at least one of an energy of a DC channel of the frequency domain division frequency layout, a variance of all pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

64. The computer readable medium of claim 63, wherein the operation (d1) comprises:

(d1a) determining the image texture descriptor based on the energy of the DC channel, the variance of all of the pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

65. A texture-based image retrieval method using a Gabor filter in a frequency domain for texture-based retrieving a data image similar to a query image, comprising:

(1) inputting a query image;

(2) determining a query texture descriptor of a query image by using a Gabor filter when the query image is input;

(3) determining a distance between the query texture descriptor and a data texture descriptor, wherein the data texture descriptor is previously stored in a texture descriptor database and wherein the data texture descriptor is determined by filtering a data image via a Gabor filter; and

(4) determining a similarity between the query image and the data image based on the distance between the query image descriptor and the data image descriptor.

66. The method of claim 65, wherein the query image is a time domain query image represented in a time domain, and

wherein the operation (2) comprises:

(a) converting the time domain query image into a frequency domain query image represented in a frequency domain;

(b) filtering the frequency domain query image via a Gabor filter having NxM filter regions to produce a filtered image, wherein N and M are predetermined positive integers;

(c) determining texture feature values of the filtered image for respective channels, wherein said channels represent a frequency domain division layout corresponding to the NxM filter regions of the Gabor filter; and

(d) determining the query texture descriptor of the frequency domain query image using the texture feature values.

67. The method of claim 66, wherein the operation (a) comprises:

(a1) converting the time domain query image into the frequency domain query image via a two-dimensional Fourier-transformation operation,

wherein the frequency domain query image is an image of an orthogonal coordinate system frequency domain.

68. The method of claim 66, wherein the operation (a) comprises:

(a1) converting the time domain query image into the frequency domain query image via a Radon-transformation operation and a one-dimensional Fourier-transformation operation,

wherein the frequency domain query image is an image of a polar coordinate system frequency domain.

69. The method of claim 66, wherein the operation (c) comprises:

(c1) determining the frequency domain division layout based one of a human visual system ("HVS").

70. The method of claim 69, wherein the operation (c1) comprises:

(c1a) defining channels within the frequency domain division frequency layout by:

(c1a1) dividing the frequency domain by an octave interval in a radial direction away from an origin of the frequency domain; and

(c1a2) dividing the frequency domain by a division resolving power interval in the angular direction over 180 degrees of the frequency domain.

71. The method of claim 69, wherein the operation (c) further comprises:

(c2) prioritizing channels of the frequency domain division layout.

72. The method of claim 69, wherein operation (c) further comprises:

(c2) calculating at least one of an energy mean value and an energy variance value for the channels of the filtered image; and

(c3) determining features values for the filtered image based on the at least one of the energy mean value and the energy variance value.

73. The method of claim 72, wherein the operation (d) comprises:

(d1) determining the image texture descriptor based on at least one of an energy of a DC channel of the frequency domain division frequency layout, a variance of all pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

74. The method of claim 73, wherein the operation (d1) comprises:

(d1a) determining the image texture descriptor based on the energy of the DC channel, the variance of all of the pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

75. The method of claim 72, wherein operation (c) comprises:

(c4) determining the distance between two texture descriptors by comparing the respective feature values corresponding to the respective channels of the filtered image of the query image with respective feature values corresponding to respective channels of a filtered image of the data image.

76. The method of claim 75, wherein the distance between the query image and the data image is measured by rotating the query image in a predetermined degree in the frequency domain, and the minimum distance is determined as the distance between two images.

77. The method of claim 67, wherein the operation (c) comprises:

(c1) determining the frequency domain division layout based one of a human visual system ("HVS").

78. The method of claim 77, wherein the operation (c1) comprises:

(c1a) defining channels within the frequency domain division frequency layout by:

(c1a1) dividing the frequency domain by an octave interval in a radial direction away from an origin of the frequency domain; and

(c1a2) dividing the frequency domain by a division resolving power interval in the angular direction over 180 degrees of the frequency domain.

79. The method of claim 77, wherein the operation (c) further comprises:

(c2) prioritizing channels of the frequency domain division layout.

80. The method of claim 77, wherein operation (c) further comprises:

(c2) calculating at least one of an energy mean value and an energy variance value for the channels of the filtered image; and

(c3) determining features values for the filtered image based on the at least one of the energy mean value and the energy variance value.

81. The method of claim 80, wherein the operation (d) comprises:

(d1) determining the image texture descriptor based on at least one of an energy of a DC channel of the frequency domain division frequency layout, a variance of all pixel values of

the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

82. The method of claim 81, wherein the operation (d1) comprises:

(d1a) determining the image texture descriptor based on the energy of the DC channel, the variance of all of the pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

83. The method of claim 80, wherein operation (c) comprises:

(c4) determining the distance between two texture descriptors by comparing the respective feature values corresponding to the respective channels of the filtered image of the query image with respective feature values corresponding to respective channels of a filtered image of the data image.

84. The method of claim 83, wherein the distance between the query image and the data image is measured by rotating the query image in a predetermined degree in the frequency domain, and the minimum distance is determined as the distance between two images.

85. The method of claim 68, wherein the operation (c) comprises:

(c1) determining the frequency domain division layout based one of a human visual system ("HVS").

86. The method of claim 85, wherein the operation (c1) comprises:

(c1a) defining channels within the frequency domain division frequency layout by:

(c1a1) dividing the frequency domain by an octave interval in a radial direction away from an origin of the frequency domain; and

(c1a2) dividing the frequency domain by a division resolving power interval in the angular direction over 180 degrees of the frequency domain.

87. The method of claim 85, wherein the operation (c) further comprises:

(c2) prioritizing channels of the frequency domain division layout.

88. The method of claim 85, wherein operation (c) further comprises:

(c2) calculating at least one of an energy mean value and an energy variance value for the channels of the filtered image; and

(c3) determining features values for the filtered image based on the at least one of the energy mean value and the energy variance value.

89. The method of claim 88, wherein the operation (d) comprises:

(d1) determining the image texture descriptor based on at least one of an energy of a DC channel of the frequency domain division frequency layout, a variance of all pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

90. The method of claim 89, wherein the operation (d1) comprises:

(d1a) determining the image texture descriptor based on the energy of the DC channel, the variance of all of the pixel values of the filtered image, the energy mean values of the channels, and the energy variance values of the channels.

91. The method of claim 88, wherein operation (c) comprises:

(c4) determining the distance between two texture descriptors by comparing the respective feature values corresponding to the respective channels of the filtered image of the query image with respective feature values corresponding to respective channels of a filtered image of the data image.

92. The method of claim 91, wherein the distance between the query image and the data image is measured by rotating the query image in a predetermined degree in the frequency domain, and the minimum distance is determined as the distance between two images.

93. A computer readable medium containing a program that executes a routine, comprising:

(1) inputting a query image;

(2) determining a query texture descriptor of a query image by using a Gabor filter when the query image is input;

(3) determining a distance between the query texture descriptor and a data texture descriptor, wherein the data texture descriptor is previously stored in a texture descriptor

database and wherein the data texture descriptor is determined by filtering a data image via a Gabor filter; and

(4) determining a similarity between the query image and the data image based on the distance between the query image descriptor and the data image descriptor.

94. The computer readable medium of claim 93, wherein the query image is a time domain query image represented in a time domain, and

wherein the operation (2) comprises:

(a) converting the time domain query image into a frequency domain image represented in a frequency domain;

(b) filtering the frequency domain query image via a Gabor filter having NxM filter regions to produce a filtered image, wherein N and M are predetermined positive integers;

(c) determining texture feature values of the filtered image for respective channels, wherein said channels represent a frequency domain division layout corresponding to the NxM filter regions of the Gabor filter; and

(d) determining an image texture descriptor of the frequency domain query image using the texture feature values.--

REMARKS

An enclosed proposed drawing correction is submitted herewith to correct minor typographical errors contained in Fig. 2. Applicants respectfully request the Examiner to approve of the drawing correction.

Also, claims 1-22 have been cancelled without prejudice or disclaimer, and claims 23-94 have been added to place the application in better condition for initial examination. Entry and consideration of this Amendment is respectfully requested.

Respectfully submitted,

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